CLAIMS

What is claimed is:

1. A method for representing a multidimensional shape, comprising the steps of:

receiving as input a plurality of points in space;

forming a plurality of shocks based on said plurality of points by initiating a plurality of wavefronts at selected points of said plurality where shocks are formed at collisions of said plurality of wavefronts, said plurality of shocks holding topology information about the multidimensional shape, said topology information including flow speed and accelerations and direction from boundaries of said multidimensional shape; and

generating a shock scaffold from said plurality of shocks, said shock scaffold representing the multidimensional shape where the multidimensional shape is capable of being reconstructed from said shock scaffold.

2. The method of claim 1 wherein said step of forming the plurality of shocks further comprises the steps of:

(a) defining a plurality of clusters within said plurality of points where each point of said plurality of points belongs to one of said plurality of clusters;

(b) examining each cluster to determine pairs of generators based on visibility constraints between points;

(c) generating a shock candidate from each of said pairs of generators;

(d) for each shock candidate,

(i) forming a contact sphere; and

(ii) examining said contact sphere to find whether said contact sphere is contained within a cluster with said shock candidate,

(1) when said contact sphere is contained with a cluster with said shock candidate, then validating each shock candidate by examining said contact sphere and its generators within said cluster

where said shock candidate is validated as a shock if no generating points other than its generators are included in said contact sphere, (2) when said contact sphere is not contained with a cluster with said shock candidate, then validating each shock candidate by examining said contact sphere and its generators within said cluster and generators in neighboring clusters also containing said contact sphere where said shock candidate is validated as a shock if no generating points other than its generators are included in said contact sphere,

whereby a plurality of shocks is created from validated shock candidates, each shock holding topology information about the multidimensional shape derived from said generators.

3. The method of claim 2 wherein the step of generating a plurality of shock candidates further comprises the steps of :

generating a first wavefront from one generator of each said pair;

generating a second wavefront from a second generator of each pair; and

determining a shock candidate from a collision point and flow direction at a collision of said first wavefront and said second wavefront.

4. The method of claim 2 further comprising the step of determining pairs of clusters after said step of determining pairs of generators, said pairs of clusters determined based on visibility constraints between clusters, said paired clusters reducing an amount of clusters to be examined in validating shock candidates.

5. The method of claim 2 further comprising the step of dynamically adding new points to said plurality of points and repeating steps b-d for each said new point.

6. The method of claim 2 wherein said shocks are A_1^2 shocks describing shock sheets associated with said multidimensional shape.

7. The method of claim 1 wherein said step of generating a shock scaffold further comprises the steps of:

generating shock curves from said shocks; and

generating a set of shock vertices of said shock scaffold from said shock curves.

8. The method of claim 1 further comprising the step of receiving connectivity information for said plurality of points in a Voronoi diagram of said plurality of points; and said step of forming a plurality of shocks is further based on said Voronoi diagram.

9. The method of claim 1 further comprising the step of computing a Voronoi diagram from said shock scaffold.

10. The method of claim 1 wherein said step of determining a plurality of shocks further comprises the steps of:

defining a fixed multi-dimensional grid in space around said plurality of points, said multi-dimensional grid including a plurality of chambers;

initiating cellular automata along said grid in a subset of possible directions from a first chamber including a first point of said plurality of points and from a second chamber including a second point of said plurality of points;

propagating said cellular automata through said grid outward from said first and said second chambers until each said cellular automaton collides with another cellular automaton; and,

determining a shock at each collision.

11. The method of claim 10 wherein at least one of said cellular automata is a three-dimensional beam.

12. The method of claim 11 wherein said three-dimensional beam is formed by pairing two two-dimensional beams covering orthogonal orientations of said grid.

13. The method of claim 10 wherein said chambers are irregularly-shaped tessellating chambers.

14. The method of claim 10 further comprising the steps of:

detecting sheet source shocks in each said chamber;

generating shock curves from said shocks in each said chamber;

generating a set of shock vertices of said shock scaffold from said shock curves in each said chamber;

propagating existing cellular automata in each said chamber;

initiating first new cellular automata from said sheet source shocks; and

initiating second new cellular automata from vertices of each said chamber in response to changes at said vertices caused by said first new cellular automata.

15. A method for representing a multidimensional shape, comprising the steps of:

receiving as input a plurality of polygons in space;

determining pairs of generator polygons based on visibility constraints between polygons in said plurality;

generating a first plurality of wavefronts from a first generator polygon in each pair;

generating a second plurality of wavefronts from a second generator polygon in each pair, where said pluralities of wavefronts include planar wavefronts from planes of said first and said second generator polygons, spherical wavefronts from said vertices of said first and said second generator polygons, and cylindrical wavefronts from edges of said first and said second generator polygons;

determining shocks from collisions of said first plurality of wavefronts and said second plurality of wavefronts; and

generating a shock scaffold representing said multidimensional shape from said plurality of shocks where the multidimensional shape can be reconstructed from the shock scaffold.

16. A shock scaffold for representing a multidimensional shape, comprising:

a plurality of shocks, each shock holding topology information about the multidimensional shape by storing position information from a plurality of generator points related to the surface of the multidimensional shape and flow direction of the surface of the multidimensional shape;

a plurality of implicit curve segments connecting said plurality of shocks; and

a plurality of implicit shock sheets described by said plurality of implicit curve segments,

wherein said plurality of shocks, said plurality of implicit curve segments, and said implicit shock sheets form a directed graph that is a representation of the multidimensional shape where the multidimensional shape can be reconstructed from the information contained in the shock scaffold.

17. The shock scaffold of claim 16 wherein each said plurality of shocks is qualified according to a number of contact points of with the multidimensional shape by a maximal sphere centered at said shock.

18. The shock scaffold of claim 16 wherein each said plurality of shocks is qualified according to a degree of contact with the multidimensional shape of a maximal sphere centered at said shock.

19. The shock scaffold of claim 16 wherein each said plurality of shocks is classed as one of a plurality of classes: (a) regular if said shock is a point at which flow is smooth, (b) source if said shock initiates flow, (c) sink if said shock terminates flow, and (d) relay if said shock is a source of flow and a termination for flow, said plurality of classes providing topology information about the multidimensional shape.

20. A system for representing a multidimensional shape, comprising:

a memory;

an interface which is configured to receive a plurality of sample points corresponding to the multidimensional shape; and

a controller coupled to said memory and said interface, said controller being configured to

(i) generate a shock scaffold to represent the multidimensional shape based on said plurality of sample points, and

(ii) store said shock scaffold in said memory, wherein said shock scaffold includes nodes defined as critical points of flow speed and direction of surface boundaries of said multidimensional shape.

21. The system of claim 20 wherein said controller includes:

circuitry which is configured to generate said shock scaffold based on said plurality of sample points and point clustering precepts and visibility constraints.

22. The system of claim 20 wherein said controller includes:

circuitry which is configured to generate said shock scaffold using wavefront propagation on a multidimensional grid, wavefronts of said wavefront propagation generated in response to said plurality of sample points.

23. The system of claim 20 wherein said controller includes:

circuitry which is configured to derive multiple sub-graphs from said shock scaffold, at least one of said multiple sub-graphs relating to a boundary of said multidimensional shape.